Remote Sensing for Crop and Water Management in Irrigated Agriculture

Doug Hunsaker, Kelly Thorp, Andy French & Tom Clarke
USDA-ARS Arid Land Agricultural Research Center
www.alarc.ars.usda.gov

Remote Sensing & Evapotranspiration

Practical, accurate, & inexpensive methods are needed to estimate crop evapotranspiration (ET) at field to regional scales for irrigated agriculture. For arid environments ET is a dominant water cycle component and an indicator of cropland productivity. Where water scarcity persists, growers and regional management agencies will need to decide where and how much water can be conserved. Remote sensing can help these decision makers by providing water use information unavailable in other ways.

Benefits

Increased on-farm water use efficiency

Improved irrigation scheduling methodologies

Improved spatial monitoring of crop health

Integration of water and nutrient management techniques for precision farming applications

Specific Outcomes

Accurate & transferable crop coefficients for the U.S. Southwest

ET algorithms for extreme weather

Remote sensing indices for crop and water stress

Assimilation techniques for remote sensing & crop models

Decision-support tools for farm-scale application

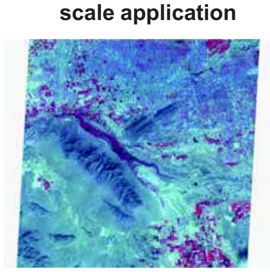

Fig. 1. View of Central Arizona region with 15 m resolution ASTER visible near infrared bands.

Project Objectives

Three strategies to improve ET estimation with remote sensing

1. Develop robust & transferable crop coefficients
2. Develop remote sensing techniques to estimate the surface energy balance, and crop water stress
3. Implement remote sensing ET techniques as decision support tools

Study Sites

Fig. 2. Maricopa, Arizona: Ground-based remote sensing.

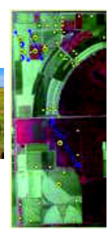

Fig. 3. Bushland, Texas: Aircraft multi-spectral.

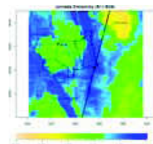

Fig. 4. Jornada, New Mexico: thermal emissivity from ASTER satellite sensor.

Crop Coefficients

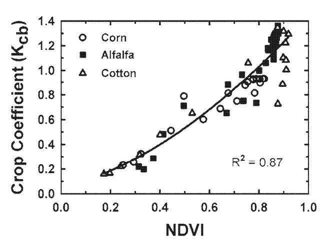

Fig. 5. Remote sensing indices help adjust crop coefficients for growth stage and non-standard conditions.

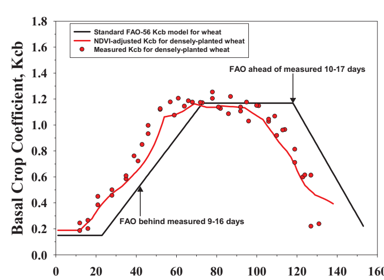

Fig. 6. NDVI-adjusted crop coefficients are better ET estimators than standardized FAO models.

Surface Energy Balance

The most robust ET retrievals are expected from physically-based models, instead of relying on local calibrations. To do this, remote sensing in visible, near infrared, and thermal infrared wavelengths is needed. Our studies require 1 m spatial resolution, which we acquire using an airborne platform illustrated in Fig. 7 below.

Fig. 7. Airborne platform for thermal and VNIR remote sensing to assess remote sensing of surface energy balance.

Decision Support Tools

Remote sensing data are believed to have the best possible spatially distributed information for irrigation scheduling, but there are many times– e.g. cloudy skies--- with no image data. So background crop models are needed to provide continuous water use forecasts. A statistically optimal way to do this is known as "data assimilation". Fig. 8 illustrates the idea, where a model is updated as new remote sensing data become available.

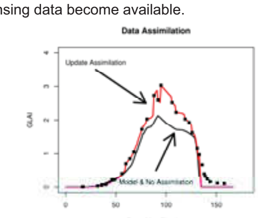

Fig. 8. Data assimilation optimally combines modeled and observed Green Leaf Area Indices.

Conclusions

Remote sensing can be a practical approach to spatially manage crops and their use of water for irrigated lands. Remote sensing provides a way to monitor crop cover, ET, and a way to compensate for crop model uncertainties.

References

Clarke, T.R. et al. 2001. Planar domain indices: a method for measuring a quality of a single component in two-component pixels. *IGARSS 2001, Scanning the Present and Resolving the Future, 9-13 July 2001, Sydney, Australia*. 1279-1281

French, A.N. et al. 2008. Detecting land cover change at the Jornada Experimental Range, New Mexico with ASTER emissivities. *Remote Sens. Environ*. 112: 1730-1748.

Hunsaker, D.J. et al. 2007 Wheat irrigation management using multispectral crop coefficients, *Trans. ASABE* 50(6):2035-2050.

Thorp, K.R. et al. 2008. Methodology for the use of DSSAT models for precision agriculture decision support. *Computers and Electronics in Agriculture*. 64(2):276-285.

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